

The highest and lowest water, mean stage, and monthly range at 212 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mis-

issippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—E. H. Bowie, Local Forecaster.

### SPECIAL ARTICLES, NOTES, AND EXTRACTS.

#### ANNUAL RISE OF THE COLUMBIA RIVER IN 1908.<sup>1</sup>

By E. A. BEALS, District Forecaster. Dated Portland, Oreg., August 26, 1908.

As is well known the annual rise of the Columbia River is almost wholly due to the melting of the winter's snow in the mountains and foot hills within the Columbia River drainage basin.

The following table shows the highest water and the date of its occurrence this year at all stations on the Columbia River and its principal tributaries:

TABLE 1.—Flood crests, Columbia watershed, 1908.

Stations.	Height.	Date.
	<i>Feet.</i>	
Bonners Ferry.....	27.8	June 10 and 11.
Newport.....	21.7	June 16, 17, 18, and 19.
Lewiston.....	14.1	June 15 and 16.
Wenatchee.....	41.0	June 18.
Umatilla.....	21.9	June 17 and 18.
Celilo.....	19.1	June 18.
The Dalles.....	37.1	June 18.
Cascade Locks.....	29.6	June 19.
Vancouver.....	22.4	June 21.
Riparia.....	13.7	June 17.
Portland.....	21.2	June 20 and 21.

The accompanying hydrograph, fig. 1, shows the behavior of the river at Wenatchee, Wash., 200 miles above the junction of the Columbia and the Snake rivers; at Lewiston, Idaho, on the Snake River, 200 miles from its mouth; and at Vancouver, Wash., about 100 miles from the mouth of the Columbia.

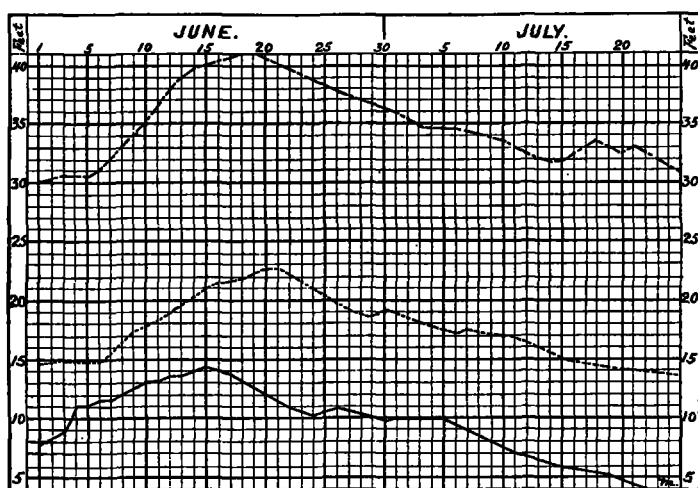


FIG 1.—Hydrographs of daily stages on the Columbia and Snake rivers.  
 ----- Columbia River, at Wenatchee, Wash.  
 ..... Columbia River, at Vancouver, Wash.  
 ——— Snake River, at Lewiston, Idaho.

As compared with last year, the rise this year was about two feet higher in the lower stretch of the river where the width was normal. The rise also occurred about twelve days later than last year. It overflowed the bottom lands to a depth of about five feet for 20 miles on either side of Vancouver. All the lower docks of the city of Portland were flooded, as well as the cellars along the water front. Forecasts of this flood were begun on May 20 and continued until July 12. They were very accurate, and the high water did

<sup>1</sup>This report was received too late for insertion in the July Monthly Weather Review.

no damage except such as resulted from the flooding of a small amount of cultivated ground.

For comparative purposes the best record of the temperature and precipitation over the drainage basin of the upper Columbia and the Snake rivers is that given monthly by Table I of the MONTHLY WEATHER REVIEW, under the subheading Northern Plateau. The average precipitation and mean temperatures together with the departures from normal in that district for November and December, 1907, and for January, February, and March, 1908, are given in Table 2.

TABLE 2.—Temperature and precipitation of northern Plateau during cold season 1907–8.

Year and month.	Temperature.		Precipitation.	
	Mean.	Departure.	Average.	Departure.
	<i>° F.</i>	<i>° F.</i>	<i>Inches.</i>	<i>Inches.</i>
November..... 1907.	41.6	+2.9	0.89	—0.5
December.....	34.8	+2.7	2.12	+0.4
January..... 1908.	32.7	+3.9	0.76	—0.9
February.....	35.2	+3.1	1.13	—0.4
March.....	41.7	+1.5	0.95	—0.6
	37.2	+2.8	5.85	—2.0

This table shows that the precipitation was about 2 inches short of the normal, but during November and December, 1907, the amount was nearly normal. The snow that fell during this time packed solidly, and at the end of March the special reports regarding the winter's snowfall showed that about the normal amount had fallen in British Columbia, northern Idaho, and western Montana, while in southern Idaho and northern Wyoming there was a slight deficiency. The temperature during the entire snow season was uniformly above normal. Taking these conditions alone into consideration, a moderate rise only could be expected, which would occur a little later than usual on account of the snow being so solidly packed.

The determining factor in this flood crest which recurs each year is not so much the amount of snow that falls as the way it melts in the spring. If the mean temperature during April is above normal, and this month is followed by a mild May, the rise unusually comes earlier, and is not apt to bring very high water. If, however, the spring is backward, and a long hot spell occurs in May, then the snow melts rapidly and high water follows. This year we had a warm April in the mountains with the temperature about 2° above normal, but May was cold and very little snow melted during that month. Consequently, when the warm weather of June came the snow melted quickly resulting in a flood crest about 2 feet higher, and nearly two weeks later than last year.

TABLE 3.—Flood crest at Portland, Oreg., during the annual rise of Columbia River.

Year.	Stage.	Year.	Stage.	Year.	Stage.	Year.	Stage.
	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>
1879.....	19.3	1887.....	25.7	1895.....	16.3	1903.....	24.0
1880.....	27.3	1888.....	18.2	1896.....	23.8	1904.....	20.8
1881.....	19.7	1889.....	10.0	1897.....	23.7	1905.....	13.6
1882.....	26.1	1890.....	20.1	1898.....	20.7	1906.....	13.4
1883.....	17.8	1891.....	14.1	1899.....	24.2	1907.....	19.2
1884.....	20.2	1892.....	19.3	1900.....	17.8	1908.....	21.2
1885.....	14.5	1893.....	22.0	1901.....	20.8		
1886.....	20.0	1894.....	33.0	1902.....	20.7		

For purpose of comparison, there is submitted Table 3, showing the stages of all the recorded flood crests at Portland, Oreg., due to the annual rise in the Columbia River.

#### THE 1907 ANNUAL RISE IN THE COLUMBIA RIVER.

Mr. E. A. Beals, district forecaster, submits under date of August 26, 1908, the following corrections to his report on the 1907 annual rise in the Columbia River, as published in the MONTHLY WEATHER REVIEW for July, 1907, XXXV, page 305:

For Table 1, substitute the following table:

*Northern Plateau.—Temperature and rainfall.*

	Temperature.		Rainfall.	
	Mean.	Departure.	Average.	Departure.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
1906.				
November.....	36.0	-0.9	1.91	+0.5
December.....	35.9	+3.6	2.54	+0.7
1907.				
January.....	24.4	-2.3	1.91	-0.1
February.....	38.4	+6.9	1.84	+0.2
March.....	41.3	+1.1	2.22	+0.5
	35.2	+1.7	10.42	+1.8

In the second paragraph of the first column of page 305, change the second word from "total" to "average." Change the third and fourth paragraphs of the same column to read as follows:

"It will be seen by this table that last year during the period of snowfall there was 1.8 inches excess in precipitation, and an excess of 1.7° in temperature. Reports gathered at the end of March from snowfall reporters in western Montana, British Columbia, Idaho, and northwestern Wyoming, were to the effect that there was more than the average amount of snow on the ground at that time, and if the amount of snow in the mountains is a gauge for the height of the subsequent flood crest, then unusually high water was to be expected later on."

"The mean temperature in the northern Plateau during April and May, 1907, was nearly normal, being only 0.8° below normal in April and 0.9° above normal in May. Also during these months there were no unusual or protracted hot spells, but, instead, the variations from day to day were quite small and uniform."

#### STORMS AND ICE ON THE GREAT LAKES.

By NORMAN B. CONGER. Dated Detroit, Mich., July 11, 1908.

#### THE DISPLAY OF STORM WARNINGS ON THE GREAT LAKES.

The storm-warning flags adopted by the Weather Bureau for announcing the approach of wind-storms are as follows:

The storm warning (a red flag 8 feet square, with black center 3 feet square) indicates that the storm is expected to be of marked violence.

The red pennant (8 feet hoist and 15 feet fly) displayed with flags indicates easterly winds; that is, from northeast to south, inclusive, and that the storm center is approaching.

The white pennant (8 feet hoist and 15 feet fly) displayed with flags indicates westerly winds; that is, from north to southwest, inclusive, and that the storm center has past.

When the red pennant is hoisted *above* the storm-warning flag, winds are expected from the northeast quadrant; when *below*, from the southeast quadrant.

When the white pennant is hoisted *above* the storm-warning flag, winds are expected from the northwest quadrant; when *below*, from the southwest quadrant.

*Night storm warnings.*—By night a red light will indicate easterly winds; a white light *below* a red light will indicate westerly winds.

The hurricane warning (two storm-warning flags, red with black centers, displayed one above the other) indicates the expected approach of tropical hurricanes, and also of those

extremely severe and dangerous storms which occasionally move across the Lakes and the northern Atlantic coast.

When orders to hoist this warning are received at any Weather Bureau station, every effort will be made by the officials and employees of the service to give the warnings the widest possible distribution, and all vessels will be notified that it is dangerous to leave port.

The regular Weather Bureau stations on or near the Great Lakes are designated by small capitals in the following lists. They are:

*Lake Superior.*—Duluth, Minn.; Houghton and Marquette, Mich.

*St. Marys River.*—Sault Sainte Marie, Mich.

*Lake Michigan.*—Green Bay and Milwaukee, Wis.; Chicago, Ill.; Escanaba and Grand Haven, Mich.

*Lake Huron.*—Alpena and Port Huron, Mich.

*Detroit River.*—Detroit, Mich.

*Lake Erie.*—Toledo, Sandusky, and Cleveland, Ohio; Erie, Pa.; and Buffalo, N. Y.

*Lake Ontario.*—Rochester and Oswego, N. Y.

Storm and hurricane warnings are displayed at all regular Weather Bureau stations, and at a number of smaller ports, designated as storm-warning stations, in charge of displaymen, who hoist the warnings and post and distribute the bulletins, giving information of the storms on the Great Lakes.

At all lake stations, except Port Huron, Mich., a chart is issued daily, except Sundays, showing the weather conditions at 8 a. m., seventy-fifth meridian time (7 a. m., Central time), over the region of the Great Lakes and to the westward. Port Huron, Mich., is supplied with charts from Detroit. Vessel masters are cordially invited to call at any of the Weather Bureau offices for these charts or any other information they may desire in connection with the weather. The official in charge of the Weather Bureau office at Detroit, Mich., has been instructed to furnish a copy of all storm warnings, in addition to the weather maps, for use of vessel masters passing Detroit. Arrangements have been made with the Post-Office Department whereby these warnings and weather maps will be delivered to the masters by the mail boat. In case the mail boat does not have mail for each boat and the master desires information of the latest weather conditions, the following code of signals promulgated by the postmaster at Detroit may be used:

Signal to passing boats from United States mail boat for delivery of mail: (Blasts) one long (————); one short (—); one long (————).

Signal to steam vessels wanting mail boat to call for mail: (Blasts) one long (————); one short (—): one long (————).

Signals for sailing vessels requiring mail boat: White flag by day. Flashing bright light at night.

Signal from mail boat to large boat to check down: Three blasts from mocking-bird whistle.

Signal from rowboat belonging to mail boat when approaching vessels for delivery of mail: White flag in daytime. Swinging bright light at night.

For ordinary storm warnings the mail boat will display a red flag with a black square center; and for warnings of severe or dangerous storms, two flags, red with black square centers. In the latter case the mail boat will deliver storm warnings to *all boats bound down*.

The Kendall Reporting Agency, at Port Huron, Mich., will deliver storm warnings to boats *passing into Lake Huron*.

Storm-warning displaymen at stations on the Great Lakes are authorized to telegraph for information regarding expected weather conditions in their vicinity whenever such information is requested by masters flying the American flag. From stations on Lake Superior, Michigan, or Huron these requests will be address to the Weather Bureau office, Chicago; from